

Current Comments®

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Using the *Citation Classic*® Database for Science Studies. Part 1. Helen Astin on Gender Differences in Author Productivity

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Another View on Women in Science

Earlier this year we discussed the topic of women in science in a two-part *Current Contents*® (CC®) essay.^{1,2} The essay examined what Harriet Zuckerman, Andrew W. Mellon Foundation, and Jonathan Cole, Columbia University, have termed the "productivity puzzle,"³ referring to the well-documented fact that women scientists publish fewer papers than men. It is a puzzle because this gender difference has yet to be satisfactorily explained.

The CC essay reprinted a study of men and women biochemists by J. Scott Long, Indiana University, Bloomington, which used data from ISI®'s *Science Citation Index*®.⁴ As reported in *The Scientist*®, his analysis confirmed that women publish less but, intriguingly, they are cited more.⁵ While he suggested several possible reasons to explain this "impact enigma," he concluded that more studies are needed to fully account for it.

Another study that used ISI data to examine gender differences between scientists was published by Helen S. Astin, University of California at Los Angeles (UCLA), in *The Outer Circle: Women in the Scientific Community*, edited by Zuckerman, Cole, and John T. Bruer, James S. McDonnell Foundation, St. Louis, Missouri.⁶ Astin based her analysis on *Citation Classic*® commentaries published in CC to determine how women and men authors differ in planning and conducting their high impact research. It is being reprinted in CC in two parts—part 1 follows.



Helen S. Astin

Astin's sample consisted of 56 *Citation Classic* commentaries, half by women and half by men, published between 1984 and 1986. She analyzed gender differences in the year of publication of high impact works, multiple versus single authorship, and types of publication—journal papers, review articles, and book chapters. Her results and analysis are presented below.

Part 2 will present the results of Astin's content analysis of the *Citation Classic* commentaries. The analysis focuses on three interesting questions: how the research was conceived; what obstacles to conducting the research or publishing it were encountered, if any; and why the authors think the work was highly cited. Gen-

der differences with respect to these questions are examined and discussed.

***Citation Classics*[®]: A New Genre in Scientific Literature**

When the *Citation Classics* feature was launched in *CC*[®] in 1977,⁷ we anticipated that these author commentaries on highly cited works would be a useful resource for sociologists and historians of science. However, our goal was to find a way to recognize a larger number of individuals for their scientific achievements. Throughout my life as a citation analyst, I have come to know of hundreds of high impact scientists and scholars. However, only a small fraction of these Nobel class scientists will receive the wide public recognition that comes with prestigious prizes, honors, academy memberships, etc. Public recognition of scientific greatness is too often a chance event.

Citation Classics have succeeded in expanding opportunities for deserving scientists to be acknowledged for their contributions. To date we have published about 5,000 author commentaries on their highly cited works. As a result, almost everywhere I lecture I encounter someone who has written a *Citation Classic* commentary and thanks me for the "honor." Indeed, *Citation Classics* have become a kind of status symbol, and many authors welcome the opportunity to describe what prompted their research, the trials and tribulations of publishing it, and other details not often revealed in formal scientific publication.

In effect, *Citation Classics* represent a new genre in the scientific literature—the "mini-autobiography" of high impact work. I find these commentaries to be a valuable reference source and continue to be heavily involved in the selection process. No doubt, they are also appreciated by the thousands of authors who have contributed commentaries. Students interested in learning more about the realities of publishing a paper with wide impact would find that these commentaries provide marvelous and instructive reading. And historians and soci-

ologists of science have already made use of these unique "oral histories." For example, in addition to Astin's paper, a recently published study by Juan Miguel Campanario, Universidad de Alcalá, Madrid, Spain, used *Citation Classics* to identify high impact works that were initially rejected in the journal peer review process.⁸

My ambition is to make all these commentaries available on compact disk (CD). This would have many advantages over the printed anthologies, published earlier in seven volumes as *Contemporary Classics* in science (see box). For example, the CD edition would include software that permits comprehensive indexing of each classic paper by author, institution, keywords, cited references, etc. In addition, the software would allow for full-text searching of the commentaries. Thus, students and researchers could more easily retrieve commentaries on papers relevant to their interests. And historians, sociologists, and information specialists could more easily perform content analyses and other scientometric studies.

About the Author

Astin is a psychologist and professor of higher education and associate director of the Higher Education Research Institute at UCLA. She previously served as associate provost of UCLA's College of Letters and Science and as interim director of the UCLA Center for the Study of Women. She has also served on the American Psychological Association's (APA) Boards of Policy and Planning as well as Education and Training, chaired the APA's Committee on Employment and Human Resources, and was president of the Division of the Psychology of Women. She was recently elected vice chair of the Board of the American Association for Higher Education.

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HELEN S. ASTIN

Citation Classics:

Women's and Men's Perceptions of Their Contributions to Science

RESEARCH AND PUBLICATION are the essentials in the production of knowledge. The extent to which research productivity affects status attainment continues to attract the attention of scholars of the sociology of knowledge. Whether research productivity affects directly status attainment of scientists has been examined by a number of scholars in the past (Crane 1965; Hagstrom

1971; Cole and Cole 1973; Gaston 1973; Reskin 1977; Long 1978; Astin and Bayer 1979; Allison 1980). However, the direction of the relationship between productivity and status attainment continues to remain somewhat unclear. For example, Crane (1965) and Long (1978) maintain that institutional location is more important to productivity than is early productiv-

ity during the graduate school years. On the other hand, Cole and Cole (1973) and Astin and Bayer (1979) argue that early productivity determines institutional placement, which in turn affects long-term productivity.

Another area of interest is the relation of gender to both research productivity and status attainment (Reskin 1977; Cole 1979; Astin and Bayer 1979; Cole and Zuckerman 1984).

The present study will explore how environmental and contextual variables and experiences contribute to gender differences in research productivity. More specifically, this study will explore the ways in which often-cited women and men scientists plan, execute, and promote their significant published work.

Background of the Research

Women in the aggregate publish less than men do; and this fact has generated numerous questions and hypotheses. Do women produce less because they have fewer research resources at their disposal or because they allocate more time to other job tasks and requirements? Are they isolated from important collegial networks? Does their professed lower level of interest in research and publication erode their productivity? Or is it the tug of family obligations? Or gender discrimination, and other institutional barriers? Thus far, research has been able to provide only partial answers to some of these questions:

- In general, women are reported to have fewer institutional resources such as research funds and graduate students who serve as research assistants.

In a study that examined facilitators and inhibitors to research productivity among highly productive scholars, men were much more likely to identify resources and graduate students as important facilitators to their productivity than were the women (Astin and Davis 1985). Moreover, data from various national surveys have demonstrated differences

among women and men with respect to financial support for their research activities and availability and use of research assistants. For example, Bayer (1973) in his normative report indicates that while 30 percent of men report financial support for their research activities, only 14 percent of women do so. More recent data (1984) from the Carnegie Survey of Faculty indicate that while 26 percent of men report having research assistants, only 11 percent of the faculty women say that they have such assistance (unpublished tabulations).

- Marriage does not appear to be a barrier to research and publication. As a matter of fact, in previous studies we have documented the positive effects of marriage on research productivity (Astin and Bayer 1979; Astin and Davis 1985). Cole and Zuckerman in a recent study reported in Chapter 6 of this volume have concluded that marriage and family obligations do not account for differences observed with respect to women's lower publication rates.

- Women are reported to be somewhat more isolated from important collegial networks. Reskin, in her thoughtful analysis of "Sex Differentiation and Social Organization of Science," suggests that "since the [collegial] role applies to relationships between scientific researchers of approximately equal status [and] because women's lower gender status is inconsistent with the implicit status equivalence of colleagues, sex stratification itself can block normal collegiality between male and female researchers" (1978:9). Furthermore, Helmreich and Spence and their colleagues in interpreting sex differences with respect to research productivity speculate that "women may be more isolated from the national 'old boy' network and thus out of touch with the 'invisible college' through which much exchange of scientific information takes place" (1980:907). However, these statements are speculations that call for further research on the issue.

While we are still exploring the hypothesized external or structural barriers to women's research productivity, we also realize that women's published research may not receive the same degree of recognition as similar research produced by men. A number of investigators have documented the fact that women's and men's work are not equally recognized by such usual academic rewards as salary, promotion, and professional recognition (Astin and Bayer 1979; Ferber, Loeb and Lowry 1978; Cole 1979). Furthermore, in an article entitled "The Productivity Puzzle," Cole and Zuckerman hypothesized that *differential reinforcement*, that is, more limited recognition and use of their research may account in part for women's lower productivity. Their research leads them to conclude that "women scientists in the 1970 cohort are slightly more responsive than men to the lack of reinforcement and considerably less responsive than men to positive reinforcement" (1984:243). In order to explore further how reinforcement may affect research productivity, we conducted the pilot study summarized in this chapter.

There is no question that perceived reputation—one's standing in the discipline or profession—influences a scientist's career progress, and that citations provide collegial recognition for one's scholarly contribution to the field. By looking at how highly cited published research by women and men scientists is conceived and by examining the reasons given by these scientists for its recognition, I hope to contribute to a greater understanding of gender differences in productivity. This analysis should also shed some light on how differential reinforcement affects women and men scientists.

While citations represent an indicator of impact, they also provide reinforcement for a scientist's work. For example, in summer 1982, a subsample of 543 highly productive academic scholars¹ were mailed a semi-structured survey questionnaire with questions about barriers and facilitators to research productivity (Astin and Davis 1985). The survey also assessed what these scholars considered their most important

piece of published work and why they considered it important. The two reasons given most often by both women and men were: that the piece broke new ground and explored a new area; that the piece was widely cited. In other words, they considered their own work important because colleagues often chose to cite it in their own publications (Astin 1983).

Since the number of citations is considered a dimension of one's status in the field by both those who cite the piece as well as the scholar's own perceptions of its importance, I designed the present study to further explore citations as an important element in research productivity. The underlying assumption is that citations act as rewards that in turn provide incentives to further productivity in research. The study was designed to determine what types of scholarly work tend to be highly cited and in how such work was originally conceived. I also wanted to know whether there are gender and field differences with respect to how scholars conceive their best work and how they carry it out. The study examines reasons why a piece might be highly cited. I chose to look at these attributions because they represent a person's causal explanations for a success-oriented event such as published research that is highly cited. It was hypothesized that attributions have a direct effect on expectancies about future performance and subsequent achievement behavior. Thus, any identified gender differences in attributions of success (i.e., reasons for high citation counts of their work) might give us some clue as to how women and men react to this form of reinforcement.

Citation "classics" and essays prepared by the authors of the classics were the primary sources of data for this study. A citation classic is a weekly feature in *Current Contents*^{®2} Publications labeled as *citation classics* are identified through the *Science Citation Index*[®] (*SCI*[®]) and the *Social Sciences Citation Index*[®] (*SSCI*[®]) data bases.

A citation classic is described by the publishers of *Current Contents* as a publication that is "highly cited": "a large number

of citations to a particular publication usually indicates that the cited work has made a significant contribution to the development of scientific knowledge in its field." The publishers of citation classics also believe that such publications have "a lasting effect on the whole of science."

How does a publication become a citation classic? The publishers of *Current Contents*® scan the citations in the various publications and select pieces that are highly cited. More specifically, certain areas of research are singled out by the publisher each year, and a search is made to identify the papers and books with the highest number of citations within these fields. The number of citations necessary to make a piece a citation classic depends on the size of the field, or the number of papers published in it. The authors of these highly cited publications are invited to prepare an essay about their publication in which they discuss (a) *what prompted the research*; (b) *any obstacles they encountered in research and publication*; and (c) *why they think the publication has been so highly cited*.

The present study is designed to examine gender and field differences with respect to the above three questions.

SAMPLE

A sample of 56 essays was used in this study. It was drawn from 589 essays which appeared in *Current Contents* published between March 1984 and July 1986. The areas covered among the sample of 56 essays included life sciences, physical, chemical, and earth sciences, agriculture, biology, and environmental sciences, and social and behavioral sciences.

The 56 essays selected for the present study included all 28 essays authored by women during the two-year span and a random sample of 28 essays authored by men and matched by field with the women's essays.

Twenty-two of the essay contributors were from foreign universities, including Canada.³

PROCEDURES

Descriptive information about the authors of each of the essays, as well as any other authors of the 56 citation classic publications,⁴ included academic field and sex. For the classic we also determined if it had single or multiple authorship, the number of authors, the type of publication (book, article, chapter, etc.), the year of publication, and the number of times cited. These were all treated as categorical variables in the analysis.

The response categories for coding the essays were developed by first reading the responses offered by the authors to the three questions: How was the research conceived? What obstacles, if any, did you encounter? Why do you think your work is so highly cited?

Two analyses were undertaken. The first compared responses of men and women to the three questions asked of the authors. The second analysis compared responses by field of study.

Results and Discussion

SAMPLE PROFILE

Of the 56 scientists who wrote an essay about their citation classic over the two and one-half-year span (March 1984-July 1986), 56 percent were from the natural sciences (life sciences, physical, chemical, and earth sciences, agriculture, biology, and environmental sciences) and 44 percent from the social and behavioral sciences. The median year of publication of the citation classic was 1967 for men, with a range of 1946-1976; for women the median year was 1970 with a range of 1943-1979. Women's median citation count was 202 with a range of 40-2,125; men's median citation was 215 with a range of 65-1,850.⁵ The citation count for each participant represents the number of publications in which it has been cited since the piece's publication date. Looking at the statistics about year of publication suggests that women in the sample tended to produce their highly cited articles during the more recent years. This is probably because the women's movement and

affirmative action have increased women's overall productivity and thus their greater visibility. It may also be because more and more women are entering scientific fields. In an earlier study comparing the research performance of academics in 1972 and 1980, we found an increase in women's research activity (Astin and Snyder 1982). Also, in a later study (Davis and Astin 1987) we failed to find any significant sex differences on four different citation indices among a recent (1982) cohort of academic scholars.⁶ These recent findings are consistent with earlier findings by Cole (1979) and Cole and Zuckerman (1984), that when women and men are equal with respect to the quantity of research production, differences in citations cease to be significant.

The issue of multiple versus single authorship was also examined. Previous research on the matter of collaboration and its effect on productivity (Cole and Zuckerman 1984) found no evidence that women are less likely to collaborate than men. Thus, their lower productivity could not be explained on that basis. The present study confirms their findings, that women indeed collaborate as often as men do: 44 percent of the citation classic publications were single-authored by either sex; the remaining 56 percent that were coauthored tended to vary somewhat in the number of coauthors depending on whether the author of the essay was a man or a woman. Twelve percent of the women had five or more coauthors compared to none of the men. Also, more men tended to coauthor only with other men (77 percent); while only 10 percent of the women had coauthored with women only. This finding is not surprising since women, being a minority, have many more male than female colleagues, therefore more opportunities for coauthorship with men.

In research of gender and research productivity, journal articles have been studied more than other types of publications. However, it is important to examine other

forms of publication as well. Thus, Davis and Astin (1987) examined the extent to which various forms of publication play a role in the scholar's professional standing, and chapters in books were found to be strong and consistent predictors of reputational standing. Likewise, in the present study we also examined the type of publication that had become a citation classic. Among citation classics we observe the following distribution of type of publication:

	WOMEN	MEN
Book	12%	0
Review article	16	22
Article	72	78

Indeed, we do observe some sex differences with respect to type of publication that represents a citation classic. However, before we conclude that women's books are more highly cited than men's books, it would be necessary to ascertain whether the women in this sample are more likely to produce books, and whether the men are more likely to produce review articles (such data were not available to us in this study).

It is important to note that both chapters and review articles are important vehicles for creating visibility. (Later in this chapter we address the issue of review articles as it relates to the explanations given by these scholars for why their publications were so highly cited.) It will also be important in the future to explore further the gender differences with respect to books as a vehicle to collegial recognition. Questions to be addressed should include the following: Do women's books have a greater influence in the field? Are the topics women choose to write books about of greater general interest to other colleagues?

[Editor's Note: In part 2, to be published in the August 30 issue of *Current Contents*[®], Astin discusses the results of a content analysis of the *Citation Classic*[®] commentaries.]

Notes

1. This sample included persons who in a national survey of academics in 1980 had indicated that over their career span they had published 21 or more articles or that they had published 5 or more articles during the two years prior to the 1980 survey. The sample of 543 includes approximately equal numbers of women and men. We selected all highly productive women and a matched random sample of men from each institution and field. The study covers all disciplines represented among academics. In order to compensate for age as a variable in the lifetime publication record, we identified the highly productive younger cohort by looking at their more recent publication record.
2. *Current Contents*[®] is a resource publication produced by the Institute for Scientific Information[®]. It lists the topics covered in over 7,000 scholarly journals. It reproduces the table of contents of these journals so that readers can scan and get a quick overview of the research studies and topics covered by the various journals in their field.
3. While all authors of the publications identified as *citation classics* are asked to prepare an essay, less than one third return these essays. Foreign scholars have a much higher rate of return.
4. While a citation classic might have had multiple authorship, often the essay was written by one of the authors, usually the senior author.
5. It is important to recognize that 25 percent of all published papers are never cited even once and that the average annual citation count for papers that are cited is only 1.7 (Garfield 1979).
6. We used four citation indices: total citation count; total number of pieces cited; citation count of the most important piece; and citations of the three most-cited pieces.

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